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ABSTRACT

Reported are results of three studies: (1) Hand Preference Consistency during Infancy and Preschool Years (K. Bathurst and A. W. Gottfried), (2) Asymmetry of Verbal Processing: Influence of Family Handedness (K. Bathurst and D. W. Kee), (3) Consistency of Hand Preference and Cognitive Development in Young Children (K. Bathurst and A. W. Gottfried). Consonant with proportions previously reported for older children and adults, results of the first study reveal a high degree in consistency of hand preference from infancy through the preschool years. Findings imply that the establishment of hand preference may emerge earlier than is currently believed and favor the theoretical view of developmental invariance in functional asymmetry. Results of the second study suggest that, when compard on a measure involving verbal processing, dextral family members show more left hemisphere asymmetry and sinistral family members are more bilateralized. Based on the behavior of 89 children who were either consistent or nonconsistent in hand preference at 18, 24, 30, 36, and 42 months of age, results of the third study indicate that cross-time consistency in drawing hand preference is significantly and pervasively related to intellectual performance for females but not for males. (RH)

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Hand preference consistency during infancy and preschool years

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There is a growing body of neuroanatomical and electrophysiological evidence of cerebral asymmetry in infants. Evidence of behavioral asymmetry in the early years is scarce. Handedness has been one major focus in the investigation of behavioral asymmetry with the predominance of this literature based on children and aoults. Little is known about the ontogeny of handedness and whether handedness becomes established in infancy. This study sought to determine whether there is cross-time consistency in hand preference during infancy and preschool years.

The data presented in this paper was part of a longitudinal study which assessed 130 children on a battery of tests from 12 through 42 mo at six mo intervals. Attrition rate was minimal with 91% (118) returning at 42 mo. Beginning at 18 mo, data were gathered on hand preference on tasks which included preferred drawing hand at 18 through 42 mo, bimanual handedness and placing pegs tasks at 18 and 24 mo, and McCarthy Laterality Index at 30 through 42 mo. Hand preference was based on the child's predominant hand usage on a number of trials within each task.

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On each task at each age, the distributions of hand preference showed that there was a high preference for right-hand usage and low preference for left-hand usage (combined: right = 77%, left = 9%). Drawing hand from 18 mo through 24 mo showed a linear increase in right-hand preference (71% to 92%) and a decrease in left-hand preference (10% to 7%). In order to determine whether the correlated proportion of right/left was stable,

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the Cochran Q test was conducted (Cochran $Q(4)=4.87$, NS), indicating that the correlated proportion was stable across the 2 1/2 year period. Fifty-nine percent of those children tested at all five ages showed invariance in hand preference. Bimanual handedness distributions were similar at 18 and 24 mo with approximately 75% at each age showing a right-hand preference. The Cochran Q test (Cochran $Q(1)=.05$, NS) indicated that the correlated proportion remained stable. The percentage of those showing the same hand preference at both ages was 72%. Placing pegs showed a downward shift in right-hand preference and a slight increase in left-hand preference between 18 and 24 mo. The correlated proportion test (Cochran $Q(1)=9.94$, $p=.002$) was significant and indicated that the proportion did change over this period. The percentage of those showing the same hand preference at both ages was 72%. The McCarthy Laterality Index showed stability from 30 to 42 mo (Cochran $Q(2)=2.00$, NS). The percentage of children showing the same preference across the three ages was 44%. In addition to cross-time findings, the data revealed that there was considerable consistency across tasks at each age. The percentage of children using the same hand across tasks were 67, 63, 71, 77, and 67, respectively.

These data show a high degree in consistency of hand preference from infancy through the preschool years. Further, the proportions are in line with those reported for older children and adults. These findings imply that the establishment of hand preference may emerge earlier than is currently believed and favor the theoretical view of developmental invariance in functional asymmetry.

Asymmetry of verbal processing: Influence of family handedness

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Right-handed people are known to process verbal information predominantly in the left hemisphere. The present study assessed the proposition that family sinistrality may be a factor in determining the degree of left hemisphere specialization for verbal processing in right-handers.

Dual-task methodology was used to assess verbal lateralization which required subjects to tap a micro key with their index finger both alone and in conjunction with a verbal activities. Because the manual activity of each hand is programmed by the contralateral hemisphere, and assuming that two independent tasks will interfere with each other more if they compete for resources in the same hemisphere, right-hand tapping should be disrupted more than left-hand tapping under concurrent conditions.

Twelve subjects with no left-handed first degree relatives comprised the dextral family group; twelve subjects with at least one left-handed parent comprised the sinistral family group. An Apple II microcomputer was used to record the number of taps in each 15 second trial. Concurrent verbal conditions included repetition of four words and solution of four anagrams, both of which were performed silently and aloud.

The dependent variable of percentage reduction in tapping rate was calculated for each hand using the formula [(TA - TC)/TA] * 100, where TA is the number of taps/second in the tapping alone condition and TC is the number of taps/second in the concurrent condition. Main effects of hand (right-hand reduction scores were larger than left-hand reduction scores, $p < .001$), mode (anagrams produced more interference than words, $p = .02$), and verbal production (aloud produced more interference than silent, $p < .001$) were found. A Family x Hand interaction ($p = .02$) indicated that the difference between hands was reliable only for dextral family members who showed right-hand reduction and left-hand facilitation effects. The sinistral family group showed reduction in both hands (see Figure 1).

The results of this study are consistent with the idea that dextral family members show more left hemisphere asymmetry for verbal processing and that sinistral family members are more bilateralized for verbal processing.

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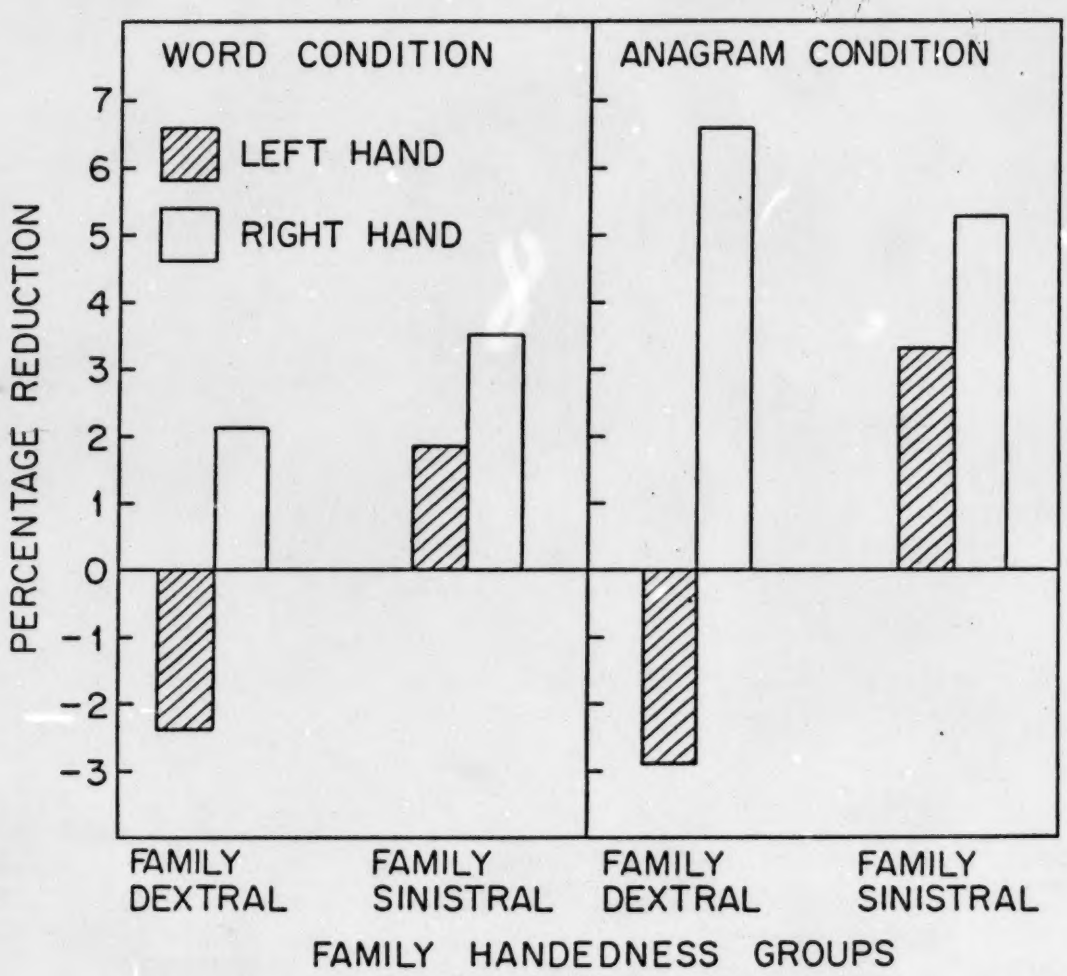

Figure 1. Mean Percentage Reduction for the right and left hand of family handedness groups in the word and anagram conditions.

Consistency of hand preference and cognitive development in young children

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In this paper, we report the results of a longitudinal investigation with infants and preschoolers which examined cross-time consistency of hand preference and its relationship to intellectual development.

One hundred thirty normal children were assessed on a battery of tests from 12 months through 42 months at six month intervals (118 returned at 42 months). Data reported were selected from the Bayley Scales of Infant Development at 18 and 24 months, and the McCarthy Scales of Children's Abilities at 30, 36 and 42 months. Both scales contain items which ask children to draw. Thus, we were able to assess consistency of hand preference on the same type of task across five ages.

Analyses were based on 89 children who were either consistent in hand preference at all five ages or who were nonconsistent. Those not included did not provide sufficient data to permit group assignment. For males, 26 were consistent and 24 were nonconsistent; for females, 21 were consistent and 18 were nonconsistent. There were no significant differences between the percentage of males (52.0%) and females (53.8%) who were consistent.

Analyses were conducted for each sex separately comparing the consistent group to the nonconsistent group at each age. Groups were compared at 18 and 24 months on the Bayley Mental Development Scale (MDI). There were no group differences between the males, however, consistent females scored significantly higher than nonconsistent females at both 18 months, $t(37)=2.40$, $p=.02$, and 24 months, $t(36)=2.32$, $p=.03$. Hotelling's T^2 were conducted on the McCarthy scales (General Cognitive, Verbal, Quantative, Perceptual, Memory, and Motor) at 30, 36 and 42 months. Again, there were no group differences for the males. For females, significant multivariate effects were found at all three ages: 30 months [T^2 $(6,31)=17.51$, $p=.04$]; 36 months [T^2 $(6,32)=21.09$, $p=.02$]; 42 months [T^2 $(6,32)=19.00$, $p=.02$]. The univariate t-tests showed that consistent females, as compared to the nonconsistent, were significantly higher on General Cognitive, Verbal, and Perceptual at all three ages, Quantitative at 36 and 42 months, and Memory and Motor at 36 months (see Table 1).

The results show that cross-time consistency in drawing hand preference is significantly and pervasively related to intellectual performance for females, but not for males.

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Table 1. Mean scores for consistent and nonconsistent male and female groups from the Bayley Scale at 18- and 24-months, and from the McCarthy Scales at 30-, 36-, and 42-months. There were no significant differences between groups for the males. For females, univariate t values are listed: *p< .05; **p< .01; ***p< .005.

	Males				Females				
	Consistent		Nonconsistent		Consistent		Nonconsistent		
Mental Test	M	(sd)	M	(sd)	M	(sd)	M	(sd)	t
18-months MDI	115.92	(14.47)	113.58	(18.65)	120.33	(13.68)	109.39	(14.74)	2.40*
24-months MDI	112.44	(21.08)	113.88	(22.49)	124.95	(15.41)	113.76	(14.00)	2.32*
30-months									
General Cognitive	113.00	(13.96)	108.42	(17.94)	119.52	(12.59)	107.41	(8.57)	3.38**
Verbal	60.24	(11.63)	56.37	(11.80)	61.10	(9.05)	54.41	(5.85)	2.63**
Perceptual	53.64	(6.02)	52.00	(7.10)	58.29	(6.97)	51.00	(5.99)	3.41***
Quantitative	55.64	(9.38)	52.79	(14.59)	60.33	(9.73)	55.06	(9.13)	1.71
Memory	59.68	(10.39)	56.11	(13.32)	62.71	(8.99)	57.41	(6.91)	2.00
Motor	52.88	(6.74)	51.84	(8.53)	54.95	(7.59)	54.71	(4.34)	.12
36-months									
General Cognitive	108.08	(12.38)	107.22	(14.80)	115.48	(10.40)	105.72	(9.58)	3.03***
Verbal	56.27	(9.46)	55.70	(9.86)	59.71	(7.75)	54.67	(6.63)	2.17*
Perceptual	52.08	(6.70)	50.35	(7.32)	56.24	(6.81)	49.94	(4.43)	3.36***
Quantitative	53.92	(8.27)	55.65	(9.84)	60.52	(6.23)	54.00	(7.72)	2.92**
Memory	55.73	(8.83)	54.61	(10.13)	58.71	(7.83)	53.39	(8.30)	2.06*
Motor	48.92	(7.21)	48.52	(7.43)	54.05	(5.86)	48.06	(5.92)	3.17***
42-months									
General Cognitive	111.77	(10.16)	110.25	(11.92)	118.67	(6.09)	111.94	(8.31)	2.91**
Verbal	57.65	(6.72)	56.79	(7.35)	61.90	(6.12)	57.72	(5.26)	2.27*
Perceptual	52.62	(8.70)	52.67	(8.07)	58.38	(6.08)	53.61	(6.67)	2.34*
Quantitative	58.15	(6.98)	57.67	(8.01)	61.29	(4.14)	55.67	(6.72)	3.19***
Memory	55.73	(7.41)	54.92	(8.20)	58.81	(5.59)	56.33	(5.29)	1.41
Motor	48.73	(10.03)	48.46	(8.10)	51.67	(6.83)	50.61	(7.06)	.47